**GENETIC REGULATION OF PROTEINS**

**NUCLEIC ACIDS**

- Double helix
- NOT made of amino acids

**Deoxyribose + phosphate + base = nucleotide**

**NUCLEIC ACIDS**

- Single helix
- Uracil
- tRNA, mRNA, rRNA

**Ribose + phosphate + base = nucleotide**

**NUCLEIC ACIDS STORE AND TRANSMIT HEREDITARY INFORMATION**

- Two types of nucleic acids:
  - ribonucleic acid (RNA)
  - deoxyribonucleic acid (DNA).
- DNA provides direction for its own replication.
- DNA also directs RNA synthesis and, through RNA, controls protein synthesis.
- Organisms inherit DNA from their parents.

**A NUCLEIC ACID STRAND IS A POLYMER OF NUCLEOTIDES**

- Nucleic acids are made from repeating nucleotide units.
- Nucleotide components:
  - a nitrogen base
  - a pentose sugar (deoxyribose or ribose)
  - a phosphate group
**NITROGEN BASES: PYRIMIDINES AND PURINES**

**Pyrimidines**
- Single ring
- Differ in attachments to the ring
- Cytosine (C), thymine (T), and uracil (U)

**Purines**
- Double ring
- Differ in attachments to the ring
- Adenine (A) and guanine (G)

**“THE PENTOSE SUGAR”**
- In DNA this is DEOXYRIBOSE
- CANNOT simply call it “sugar” on the AICE exam!

**PUTTING IT TOGETHER...**
- Nitrogen base + deoxyribose = nucleoside
  - Nucleoside monophosphate = nucleoside + phosphate (nucleotide)
  - Two phosphates would be a nucleoside diphosphate

**WHAT’S IMPORTANT ABOUT NUCLEOTIDES?**
- Different combinations are endless
- Give us all of our possible genes
  - hundreds to thousands of nucleotides long
  - “code” for different genetic traits
- Many genes make up a genome
  - All of the genes in a given organism
  - Complete genetic code

- The amino acid sequence of a polypeptide is programmed by a gene.
- A gene consists of regions of DNA, a polymer of nucleic acids.
- DNA (and their genes) is passed by the mechanisms of inheritance—more to come later!!
The Central Dogma: The flow of genetic information is from DNA -> RNA -> protein

- Protein synthesis occurs in ribosomes
- In eukaryotes, DNA is located in the nucleus, but most ribosomes are in the cytoplasm with mRNA as an intermediary
  - So how will we get this genetic code to where it needs to be?

**WHAT DO GENES DO?**

- Each gene in a strand of DNA is the code for a single protein
- Recall that proteins are what DO everything in your body
- The order of nucleotides in genes, organized in “the triplet code,” is what determines the order of amino acids in the protein
- Three nucleotides determine one amino acid

**DNA STRUCTURE**

- Double helix
- Nucleotides in the middle
- Nucleotides bond to deoxyribose-phosphate “backbone”

**BASE PAIRING RULES:**

- In DNA, adenine (A) always pairs with thymine (T) and guanine (G) with cytosine (C).
- With these base-pairing rules, if we know the sequence of bases on one strand, we know the sequence on the opposite strand.
- The two strands are complementary.
- “Go Climb A Tree”
**DNA molecules are passed from parents to offspring, so...**
- siblings have greater similarity than unrelated individuals of the same species.
- This argument can help develop a molecular genealogy between species.
- Two species that appear to be closely-related based on fossil and molecular evidence should also be more similar in DNA and protein sequences.
- The sequence of amino acids in hemoglobin molecules differ by only one amino acid between humans and gorilla → BEAUTIFUL!!

**WE CAN USE DNA AND PROTEINS AS TAPE MEASURES OF EVOLUTION**

**DNA REPLICATION**

- First step in replication
- Double helix unwound by topoisomerase
- Double helix is “unzipped” by the enzyme DNA helicase
- Enzyme breaks apart the hydrogen bonds between each set of base pairs
  - A-T have 2 hydrogen bonds compared to 3 hydrogen bonds in G-C

**BEGINNING TO BUILD THE NEW DNA STRANDS**

- As the DNA molecule is “unzipped,” new complementary strands are built up along each parent strand
- Creates a “replication fork”
- This process is accomplished by the enzyme DNA polymerase
- Attaches new nucleotides to the free 3’ end of the deoxyribose sugar
3' TO 5' PRIME CHAIN BUILDING:

• Continuous 3' to 5' building is what creates the LEADING STRAND

While DNA polymerase builds DNA up in the leading strand direction...

• A slightly different type of DNA polymerase begins building in the 3' to 5' direction

• Creates discontinuous sections of DNA called Okazaki fragments, marked off by RNA primase

• This is because DNA can only build from a 3' to 5' direction (can only attach to the 3' end)

• Referred to as the LAGGING STRAND

LEADING AND LAGGING STRANDS

LEADING AND LAGGING STRANDS

http://www.youtube.com/watch?v=mtLXpgHkildFeature=related

MEMORY TRICK

• Leading strand: LEADS the way, moves continually in the same direction

• Lagging strand: LAGS behind because it is building DNA in small sections
DNA CLEAN-UP

- **DNA ligase** comes in and adds in any additional phosphates needed to complete the DNA chain.

SPEED OF REPLICATION

- Average human chromosome is 150 x 10^6 nucleotides long.
- Nucleotides are copied at about 50 BP a second.
- Replicating a single DNA molecule would take a month, except...
- Multiple points of origin of replication which leads to replication bubbles.


Crash Course: [DNA and Replication](http://www.youtube.com/watch?v=8kK2zwjRVsM) (this is great and you're not going to make fun of it)

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